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*The*
*Papua and New Guinea*
# *Agricultural Journal*

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## Former Issues of *Gazette* and *Journal*

The following numbers of the *Agricultural Gazette* have been issued :

*New Guinea Agricultural Gazette*—

Volume 1, Number 1.
Volume 2, Numbers 1, 2 and 3.
Volume 3, Numbers 1 and 2.
Volume 4, Numbers 1, 2, 3 and 4.
Volume 5, Numbers 1, 2 and 3.
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Volume 9, Numbers 1, 2, 3 and 4.
Volume 10, Numbers 1, 2, 3 and 4.
Volume 12, Numbers 1, 2, 3 and 4.

Copies of all numbers of the *Gazette* to Volume 7, No. 4, are out of print.

PLATE I.—*Young cacao grown from cutting at Keravat.*

# CLONAL CACAO AT KERAVAT.—I. *

I. L. EDWARD †

*Since* 1947, *work designed to improve the standard of planting material of Theobroma cacao has been carried out at the Lowlands Agricultural Experiment Station, Keravat, New Britain. This paper deals with one aspect of the improvement programme—vegetative reproduction of high-yielding, high-quality cacao, with particular regard to cuttings. It discusses the use, background and establishment of cuttings and has been written specifically for commercial growers who are now in a position to obtain limited supplies of some Keravat clones. Pitfalls for growers attempting to use cuttings from their own selections are emphasized, together with notes at some length on establishment, in which stress has been placed on the degree of care necessary for success.*

NEW Guinea Trinitario cacaos are highly heterozygous in nature and cross-pollination between trees is widespread. The result is that these cacaos do not "breed true". Bridgland (1959) has drawn attention to the scope for improvement and the great variation in yielding ability within seedling plantings. For this reason, the large-scale multiplication of trees, selected for high-yielding ability, together with apparent requisite quality features, has been

* Part II of this paper will appear in a subsequent issue of the *Papua and New Guinea Agricultural Journal*. It will be concerned mainly with the actual rooting process and will include reports of experimental results to date, particularly on hormone-type rooting stimulants, choice of planting material, hardening methods, potting media, pot types, and other miscellaneous data.

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undertaken by means of cuttings. Cuttings have exactly the same inherent yielding and quality potential as the original seedling from which they are taken.

### *Probable Role of Cuttings in Territory of Papua and New Guinea*

Bridgland also states that the ultimate aim of the improvement work at Keravat is to produce both "clonal" and "hybrid" cacao seed to meet high standards of yielding ability, precocity, quality, etc. However, he has also indicated that there should be distribution of carefully selected and tested cuttings from Keravat. Such distribution is regarded by this Department mainly as a stop-gap towards plant improvement until the above-mentioned seed becomes available. When seed capable of performing as well as cuttings is produced, its economic advantages will eliminate the use of cuttings in commercial plantings.

### *Warning to Growers*

As the whole basis for attaining greatly improved yields by means of cuttings lies in the long-term programme which goes into the selection of the original seedling trees, growers are specifically advised against attempting to use cuttings from their own selections in endeavours to improve their planting material.

Most planters do not have accurate records of the amount of cocoa that particular trees have yielded, nor have they the facilities for estimating skin percentages, cacao butter-fat contents, bean size and bean defects, all of which have tremendous value from the manufacturer's point of view. Trees selected and propagated with defects in bean quality could substantially affect the price received for beans produced.

Additionally, there is the question of compatibility of pollen. In some self-compatible trees, it appears that self-pollination may lead to the production of defective beans. Self-incompatible trees, which form a high percentage of our cacao population, normally require pollen from a self-compatible tree to set fruit. Large monoclonal blocks of self-incompatible trees would therefore set no fruit unless suitable pollinators were present. Investigations concerning this and allied points are being carried out.

Differences between selected seedlings and cuttings taken from them are also frequently observed (see below). These differences may be due, among other things, to faulty or biased selection methods, such as selection of trees growing under highly favourable competitive conditions or on particularly fertile patches of soil. Yields are thus unduly inflated by environmental factors rather than by the inherent factors in which the selector is really interested. Cope (1951) put forward an explanation for these differences on the basis of comparative root efficiency, but whatever the reasons for the differences it is an established fact that they exist. This makes it absolutely necessary for adequate testing of the selections actually grown as cuttings before expected performances may be predicted with confidence.

Finally, differing performances of clones under varying climatic and soil conditions are almost certain to occur. For this reason Keravat clones have been established for testing at Kubu, near Sohano, on Bougainville, and trials in other centres are projected.

### *Specific Examples of Seedling/Cutting Differences*

The original Keravat selection K17-101 at nine years was only 10 to 12 feet in height and, although precocious in yield, the vigour left much to be desired. The lack of stature was acompanied by sparse foliage with only small leaves. The tree was also being suppressed to a marked degree by vigorous surrounding trees. However, cuttings of this selection were found to be among the most vigorous of our clones. At three years, they are approximately equal in size to the original seedling and are commencing to bear well.

Conversely, cuttings of K24 and K4-101, both large and vigorous as seedlings, have made lamentable growth, being less than five feet in height with only a few weak branches at two and a half years and improving little with time. Such selections, although of use to Keravat in the breeding programme, could never be considered as commercial clones.

The K1 selections, three in number, yielded well and reasonably early as seedlings, and their cuttings proved easy to root. The selections have made excellent growth and from the nurseryman's point of view they are ideal. However, these cuttings are apparently rather late in maturing, a marked defect in those plantings where an early return is an economic necessity.

For plantations with established mature crops providing an income, this would not be regarded so seriously if total yields over the economic life of the trees were comparable with more precocious clones.

These examples illustrate the need for adequate yield testing before large-scale plantings are undertaken, and they substantiate the advice given to growers not to use cuttings from their own selections.

## ESTABLISHMENT OF A CLONE

Bridgland (1959) has recently described the aims and methods of cacao improvement at Keravat.

Simplified, the production and eventual release of a clone follows along the general lines described below.

*Selection* of a seedling tree with desirable yielding and quality characteristics. Cuttings are taken from this and planted in—

*Material Nurseries* which are lines of cuttings from the selected tree grown under suitable conditions (See Part II), simply to supply large quantities of cuttings for mass production and planting in—

*Clone Testing Blocks* (a self-explanatory term). Here the clone's performance will determine its future and the clone will be either—

*Discarded* due to poor yield, vigour, quality or pest resistance defects, etc.

or

*Retained,* having satisfactorily met the stringent requirements laid down. Once a clone comes within this category, it may then pass to the grower.

### *Spacing and Pruning of Cuttings*

Trials involving five different spacing treatments, each pruned and unpruned, have been established, but until precise data are available,

PLATE 2.—*Young seedling. The trunk with branches arising well above ground level is quite clear.*

PLATE 3.—*Young cutting carrying an early crop. Note branches arising at ground level.*

PLATE 4.—*Straggly habit. Harvesting could be a problem. If pruning was adopted, this would involve removal of very high proportion of foliage.*

no concrete recommendations can be made. However, from experience gained to date, it seems probable that hedge-type spacings will prove to be the most suitable for cuttings. Particular spacings being examined include hedges 18 feet apart with the cuttings four feet and six feet apart within the row.

## FORM OF GROWTH

Most planters have observed that cacao trees have dimorphic branching, that is, two types of branches, each with a typical leaf arrangement.

As a seed develops, it produces a single stem, the chupon, which becomes the main trunk of the tree. The leaves on the chupon form a spiral, approximating eight leaves for every three turns around the branch. The chupon forks into three to eight branches at the jorquette, usually forming a wine-glass shape. These branches are "fan" branches and have their leaves arranged on a single plane and alternately opposite. The jorquette may arise at 2 ft. 6 in. to 9 ft. or more above ground level, the height being largely a genetic characteristic of the tree, but it is commonly around 3 ft. 6 in. to 4 ft. 6 in.

All Keravat cuttings are taken from "fan" material and this results in a totally different form of growth. Perhaps the simplest description is to say that a fan cutting looks like an ordinary seedling without a trunk, the branches arising at ground level, with the qualification that at least in the early years there is a greater number of branches (Plates 2 and 3).

This habit could result in accessibility problems and is one reason why hedge spacings will probably prove most suited for cuttings. On one area at Keravat, now three and a half years and planted at 12 foot square, the clones have formed an almost impenetrable thicket, but it must be realized that this area has been deliberately left unpruned. Another area, now seven years, and planted at 12 feet on the equilateral triangle, has been pruned and is reasonably accessible, but the effect of pruning on yield is not assessable on this area for technical reasons.

### *Variations in Form of Growth*

Wide variations in the form of growth from clone to clone are evident. These variations fall mainly into four categories :—

(*a*) Straggly, many branches growing along the ground ;

(*b*) Most erect, with few branches, and growing quite tall ;

(*c*) Compact and bushy, branches frequently just above ground level, with a neat appearance ; and

(*d*) Branches widespread, 45 degrees or less from the ground, with a markedly open centre to the bush.

The effect of the form of growth on future pruning and spacing treatments remains to be determined. The form of growth will also affect, to some extent, the period before the cutting commences to shade out the weeds at its base.

## ESTABLISHMENT OF ROOTED CUTTINGS

The grower wanting to use cuttings must realize that they are extremely valuable in potential yielding ability and expensive to procure or produce. He should therefore be prepared to take considerable trouble with the cuttings, particularly in the first 12 months after planting. During this period they are not nearly as vigorous as seedlings and require careful nursing. Apart from the economics of losing expensive planting material, it is emphasized that the treatment which a cutting receives in this period will almost entirely determine its future performance. Rough methods which, although not ideal, can be " got away with " when using seedlings, will certainly not do for cuttings. They will result in disappointment and financial loss. Shade requirements must be strictly adhered to and planting techniques should follow closely the details given below.

PLATE 5.—*Compact, bushy, neat appearance.*

PLATE 6.—*Erect habit. This cutting is about* 10 *feet in height.*

### *Transport of Cuttings Within Gazelle Peninsula*

(For bare root transport away from this area, see Part II.)

The aim here is to move the cuttings with as little disturbance of the soil-root association as possible, and to minimize the physical damage and water loss on leaves, due to wind. The cuttings should best be moved in the cool of the evening, or during light, showery weather. Excessive speeding and jolting of vehicles must be avoided. All cuttings are sent from Keravat in baskets at present (see Part II—Polythene Bag Technique) and these should be tightly packed together. It is an advantage to have three or four inches of levelled sand on the bottom of the truck, as this reduces movement of baskets appreciably and probably assists as ballast.

### *Upon Receival*

A shaded area allowing 25 to 30 per cent. of well-dappled natural sunlight, where the cuttings can be watered, is necessary for the first few days. Should prevailing weather allow, a slight increase in light intensity is permissible. One fairly good soaking designed to refirm the soil around the roots immediately after receival is advantageous. For the next few days, very light but frequent applications, as with a knapsack spray, are required, using only sufficient to moisten the leaves.

The open-sided nature of the baskets, the spreading type of root system and the very light soil supplied make it imperative to ensure that baskets are not allowed to dry out at any time. This will result in desiccation and death of the roots.

No fertilizer applications should be made because—

(1) Fertilizer is unnecessary with the type of potting soil used ; and

(2) There is danger of damage resulting from injudicious methods of application and/or excessive quantities or concentrations.

*Leucaena glauca* is a most suitable shade source during this holding period.

### *Stage for Planting*

Provided that a cutting has successfully hardened off two flushes (i.e., has six to 10 hardened leaves) it is regarded as satisfactory for planting out under Keravat conditions. Such a stage is normally reached 12 to 15 weeks after the cuttings have been first set in the propagating units. Larger cuttings can be quite readily planted out, but for reasons discussed below (under 2) care should be taken to ensure that serious rotting of the basket does not occur.

Rebasketing, as carried out so frequently overseas, is a very costly process, and is not favoured at Keravat. With the excellent growth made here, combined with the earlier stage of planting employed compared with overseas, it should be unnecessary.

### *Planting Out in Field*

Losses immediately after planting, if any, should seldom exceed one and a half to two per cent. and with some attention to detail, may frequently be eliminated. Factors affecting post-planting losses include—

(1) *Weather.* Experience has shown the advantages of planting in the rain. Planting in drier weather may be done but, without close attention to 2 and 3 below, increased losses may result.

(2) *Undue Disturbance of the Potting Soil.* This can be quite serious, the end effect being a severe water deficiency in the leaves, with subsequent death of the leaves. Cacao cuttings with all leaves lost invariably die. The sensitivity of cacao leaves to water losses has been described at Turrialba (1952) and once the soil-root association is seriously interfered with the major source of moisture to the plant is lost. Baskets, when being moved to planting holes, should therefore be supported on the hand and not merely carried by the top of the basket.

(3) *Removal of the Basket.* Baskets are made of several species of "bush rope" (species undetermined) and the ribs are of *Donax grandis*, a common bush plant. Under no circumstances, regardless of the apparent "rottenness" of the baskets in older cuttings, should the cutting be planted without the prior removal of the basket. Observations, together with the digging up of a number of cuttings, have demonstrated a marked restriction of root development when basket and all has been planted, resulting in bench rooting and falling over of trees. A

PLATE 7.—*First step in planting. The basket is carefully cut down one side and across the bottom.*

PLATE 8.—*The undisturbed ball of soil is carefully removed from the basket.*

secateur should be used to cut carefully down one side and across the bottom of the basket. The sides should then be pulled apart and the undisturbed ball of soil removed. (See Plates 7 and 8.)

(4) *Level of Planting.* The practice (commonly observed with seedling plantings) of planting in a saucer-shaped depression should be avoided and care taken to see that the soil at the base of the plant, after being firmed down, is level with the surrounding soil.

(5) *Snail Baits.* Always use paper baits (Bridgland and Byrne 1958) in areas infested with the Giant Snail, *Achatina fulica.*

(6) Care should be taken to see that shade is not excessive in the planting block. This is largely a matter of judgment and experience. Excessive shade inhibits bud development, whereas excessive light results in dwarfing, chlorosis and sometimes death of the foliage.

### *Care in the First 12 Months*

All cuttings should be carefully ring weeded *by hand* at intervals short enough to ensure that they do not have to compete too strongly with weeds for water and nutrients. The differences in nature of the root systems, together with the large initial discrepancies of relative height increases of cuttings and seedlings of cacao, make a more frequent weeding of cuttings necessary for at least the first 12 months.

The root system of a cutting for this period is largely confined to the first inch or two of soil, rendering it particularly susceptible to damage by hoes, knives, sarifs, etc. The root system of a seedling is initially of a less widespread but far deeper type, with a definite tap-root.

It may be as well at this stage to answer a frequently asked question—"Does a cutting have a tap-root?" Strictly speaking, the answer is "No". However, we have observed at Keravat, in a number of cuttings planted as recommended above and later dug up, that a large root, or roots, up to two or three in number, has taken over the role of a tap-root. At three years of age there is no apparent difference in size between the genuine seedling tap-root and the "pseudo" tap-root of the cutting.

Early height differences between seedlings and cuttings also make it necessary for frequent weeding, unless the cutting is to be "buried" under weeds, and so starved for light. At 12

PLATE 9.—*The cutting planted and ring-baited against the Giant African Snail.*

months of age it may be expected that a cutting will be about 2 ft. 6 in. in height, with a margin of six inches either way. By this time frequent weeding is no longer necessary. A seedling at this age could normally be expected to attain a height of 4 ft. 6 in. to 5ft. 6 in. Wide variation may be expected to occur.

### *Period 12 months to Bearing*

With development, hand weeding becomes unnecessary. Cuttings with branches rising from

ground level provide sufficient shade for weed control around the base at an earlier stage than seedlings. Recommendations for sarifing between lines of trees and shade requirements are, until more is known, the same as for seedlings.

### *Pest Control*

One minor pest which has attacked cuttings grown at Keravat is the longicorn beetle *Glenea aluensis*. Damage is caused by the larvae of this beetle, the eggs being deposited in the bark. The developing larvae bore into the trunks of the cutting, particularly just above ground level where several branches arise together. A gummy exudation is invariably associated with the wound.

Control measures recommended by Dun (1959) and found highly effective involve scraping away the gummy exudate and applying approximately ½-1 cc of 15 per cent. Dieldrin concentrate with a small camelhair brush (child's piant brush is ideal) directly to the wound. One gallon of Dieldrin concentrate will treat approximately 3,000 wounds.

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# ANIMAL HEALTH PICTURE OF THE TERRITORY OF PAPUA AND NEW GUINEA

J. L. Anderson *

THE Animal Health Service of the Territory of Papua and New Guinea has been developed only in the postwar period. The Division of Animal Industry now has seven Veterinarians and four Stock Inspectors, who are responsible for these services.

The Territory of Papua and New Guinea is in a happy position in relation to serious infectious animal diseases which are present in many other countries. In particular, the virus diseases, such as foot and mouth disease and rinderpest of cattle, swine fever of pigs, newcastle disease of poultry and rabies, have never been recorded. Infectious anaemia of horses was present in Japanese horses during the war, but following the destruction of all these animals, it has not been seen again. Contagious bovine pleuropneumonia, a serious problem in Northern Australia, is not present.

Protozoan diseases have been recorded. Tick fever or bovine piroplasmosis was present in New Guinea, and anaplasmosis was seen only in cattle in quarantine *en route* from Pakistan to Australia. In areas where piroplasmosis was recorded the vector of the disease has been eliminated.

The vector of these protozoan diseases, the common cattle tick, *Boophilus microplus,* is present as a legacy from the pre-war importations of cattle from Queensland. The Division of Animal Industry has an active policy of eradication of this organism on a progressive basis until the whole Territory is tick-free. This policy has proved successful in the Highlands Districts, Morobe District and New Britain District in New Guinea and the Sogeri Subdistrict of the Central District of Papua. The major cattle-raising areas of the Territory, with the exception of part of the Central District of Papua, are now tick-free.

Bacterial diseases of public health importance, such as bovine tuberculosis and bovine brucellosis are similarly subject to active eradication programmes. The incidence of tuberculosis in all cattle under test during 1958-59 was 0.062 per cent. The only districts which have not been completely tested are the Morobe and Madang Districts of New Guinea. The disease has been eradicated from the other major areas. Cattle under test in 1958-59 are shown in Table I.

TABLE I

*Tuberculosis Testing*

| District | Number of Animals Tested | Number of Reactors | Percentage |
|---|---|---|---|
| Central .... .... | 575 | Nil | 0 |
| New Britain .... | 2,055 | Nil | 0 |
| Highlands .... .... | 1,966 | 2 | 0.11 |
| Morobe .... .... | 183 | 1 | 0.54 |
| Gulf .... .... | 37 | Nil | 0 |
| TOTALS .... .... | 4,816 | 3 | 0.062 |

Brucellosis has been recorded in all major cattle raising districts, but with only a relatively low incidence. The disease has been eradicated from New Britain District of New Guinea and the incidence in the Highlands Districts of New Guinea and the Central District of Papua has been reduced to such a low level that eradication is imminent. Table II shows the animals under test in 1958-59 by districts :—

TABLE II

*Brucellosis Testing*

| District | Number of Sera Tested | Number of Reactors | No. of Holdings Infected | Percentage |
|---|---|---|---|---|
| Central .... | 1,132 | 6 | 1 | 0.05 |
| New Britain .... | 3,464 | 17 | 1 | 0.05 |
| Highlands .... | 835 | 6 | 1 | 0.72 |
| Morobe .... | 157 | Nil | Nil | Nil |
| Madang .... | 391 | 14 | 2 | 3.58 |
| TOTALS .... | 5,979 | 43 | 5 | 0.72 |

* Veterinary Officer, Department of Agriculture, Stock and Fisheries, Port Moresby.

A disease which seems unique to the Territory is present in the Highlands Districts. This is an atypical form of anthrax which manifests itself only in pigs. It is enzootic to the Eastern, Western and Southern Highlands and at intervals epizootics of the disease will sweep through sections of the pig population, leaving a trail of dead pigs in their wake. Vaccination with proprietary spore vaccines has helped in field control of the outbreaks, but laboratory tests with the vaccine have been inconclusive. Penicillin will also help in individual cases. Transmission tests with cattle, sheep and horses have been unsuccessful, but guinea-pigs are susceptible. There have never been any recorded cases of anthrax in the native population, even when affected animals have been eaten. This disease is under investigation by officers of the Division of Animal Industry and a complete prohibition on the movement of pigs out of the affected areas limits its spread.

Another disease present in the Territory of Papua and New Guinea, which is absent from Australia, is the infection with screw worm fly larvae. This fly, *Chrysomyia bezziana,* is present throughout the Territory, although at altitudes above 5,000 feet the problem is not as severe as it is in the coastal areas. The larvae have been recorded from cattle, horses, pigs, dogs and cats in all parts of the Territory. The female fly deposits its eggs beside any wound and the larvae, after hatching, burrow actively into the flesh of the host animal. Wounds as small as tick bites have been struck when the fly is active. All the normal station procedures, such as branding, marking and castrating calves, provide wounds for this parasite. New-born calves are struck on the navel and unless treated will be killed by the depredations of the larvae. This disease has meant that the rearing of cattle in this Territory must be undertaken on a much more intensive pattern than in Australia. All animals should be inspected at least every second day so that fresh strikes can be treated before they have caused irreparable damage to the animal. Calving must proceed under close supervision so that each calf can be treated with a preventive ointment.

The recommended control measure for this disease is the spraying of all cattle and horses with an insecticide of long residual effect, such as dieldrin, at intervals of about six weeks. This interval may be reduced in the wet season, when the fly is more active, and increased in the dry season. The interval will depend on the incidence of strikes observed on the animals. Individual fly strikes can be treated by spraying with insecticide. However, a proprietary smear* is available which gives excellent results.

As the climatic conditions of the Territory are conducive to the infestation of animals with internal parasites, management must be introduced which will lower the levels of infestation. The control of internal parasites in pigs and poultry is especially important so that food conversion may be at its highest level. Kidney worm (*Stephanurus dentatus*) is widespread and causes losses in pigs under poor management.

Nutritional disorders and deficiencies have been diagnosed in pigs and poultry, but the knowledge of these diseases in cattle in this Territory is scanty. In many places the rearing of cattle is a very recent introduction and deficiencies which are known to exist from plant and soil analysis have not had time to show themselves in the grazing animal. Iodine deficiency has been demonstrated. Responses have also been obtained from drenches of an iron, copper and cobalt mixture. Cattle become extremely salt hungry and salt licks containing calcium, phosphorus and trace elements are commonly used.

Of considerable importance in this Territory is the failure of British breed cattle to adapt themselves to the hot, humid lowland environment and coarseness of natural pastures in this environment. Introductions have been made of Zebu-type animals for cross-breeding with these British breeds in an attempt to produce a type which will grow well under local conditions.

The following is a list of diseases and parasites of domestic animals which have been diagnosed in the Territory of Papua and New Guinea :—

* EQ335 Screw Worm Smear (I.C.I.).

# ANIMAL DISEASES AND PARASITES OF THE TERRITORY OF PAPUA AND NEW GUINEA.

| CATTLE | DISTRIBUTION | NOTES |
|---|---|---|
| DISEASES :— | | |
| 1. Virus : | | |
| Ephemeral Fever (Three-Day Sickness) | Central District Papua | One outbreak March-June, 1959. |
| Nasal Granuloma | New Guinea | |
| Papillomatosis | Territory wide | |
| 2. Bacterial : | | |
| Arthritis PPLO | Papua | |
| Actinobacillosis | Papua | |
| Actinomycosis | Papua | |
| Brucellosis | Territory wide | Under eradication. |
| Calf diphtheria | Papua | |
| Foot abscess | Territory wide | |
| Hepatic abscess | Territory wide | *Corynebacterium pyogenes.* |
| Keratitis | Territory wide | Infections following importations. |
| Listeriosis | Papua | |
| Mastitis | Territory wide | *Strep. agalactiae* *Staph. aureus* *Escherichia coli.* |
| Pasteurellosis | Papua | |
| Salmonellosis | New Britain | |
| Tuberculosis | Territory wide | Under eradication. |
| 3. Spirochaetal : | | |
| Leptospirosis | Papua | Positive titres for *L. pomona.* |
| 4. Fungal : | | |
| Mycotic dermatitis | Territory wide | |
| 5. Nutritional : | | |
| Iodine deficiency | Territory wide | |
| PARASITES :— | | |
| 1. Protozoan : | | |
| *Anaplasma marginale* | Papua | Cattle in quarantine *en route* Pakistan to Australia. |
| *Babesia bigemina* | New Guinea | |
| *Babesia argentina* | New Guinea | |
| *Eimeria auburnensis* | Papua, New Britain | |
| *Eimeria bovis* | Papua, New Britain | |
| *Eimeria zurnii* | Papua, New Britain | |
| *Theileria mutans* | Papua | Cattle in quarantine *en route* Pakistan to Australia. |

| CATTLE—*continued* | DISTRIBUTION | NOTES |
|---|---|---|
| 2. Arthropod : | | |
| *Amblyomma cyprium* | Territory wide | Also on deer. |
| *Boophilus microplus* | Territory wide | Also on deer. |
| *Chrysomyia bezziana* | Territory wide | |
| *Chrysomyia megacephala* | Territory wide | |
| *Chrysomyia micropogon* | Territory wide | |
| *Haemaphysalis* sp. | Territory wide | |
| *Haematopinus eurysternus* | Papua | |
| *Ixodes* sp. | Papua | |
| *Musca vetustissima* | Territory wide | |
| *Rhipicephalus sanguineus* | Papua, New Guinea | |
| *Sarcoptes* sp. | Papua | |
| *Siphona exigua* | Territory wide | |
| *Stomoxys calcitrans* | Territory wide | |
| *Tabanus* sp. | Territory wide | |
| 3. Trematode : | | |
| *Fasciola hepatica* | Papua, New Guinea | |
| *Paramphistomum cervi* | Territory wide | |
| *Paramphistomum cotylophorum* | Papua | |
| 4. Cestode : | | |
| *Echinococcus granulosus* | Papua | One recording in imported cow. |
| *Moniezia expansa* | Territory wide | |
| 5. Nematode : | | |
| *Bunostomum phlebotomum* | Territory wide | |
| *Bunostomum* sp. | Territory wide | |
| *Cooperia punctata* | Papua | |
| *Cooperia* sp. | Territory wide | |
| *Dictyocaulus filaria* | Territory wide | |
| *Haemonchus contortus* | New Guinea | |
| *Haemonchus placei* | Territory wide | |
| *Nematodirus* sp. | Territory wide | |
| *Oesophagostomum columbianum* | Territory wide | |
| *Oesophagostomum radiatum* | Territory wide | |
| *Onchocerca gibsoni* | Territory wide | |
| *Ostertagia* sp. | Territory wide | |
| *Strongyloides papillosus* | Territory wide | |
| *Strongyloides* sp. | Territory wide | |
| *Trichostrongylus* sp. | Territory wide | |
| *Trichuris globulosa* | Papua | |

| HORSE | DISTRIBUTION | NOTES |
|---|---|---|
| DISEASES :— | | |
| 1. Virus : | | |
| Equine infectious anaemia | New Britain | In Japanese army horses—not seen since. |
| 2. Bacterial : | | |
| Brucellosis | New Britain | Fistulous withers. |
| Hepatic abscess | Territory wide | *C. pyogenes.* |
| Keratitis | New Guinea | |
| Tetanus | Territory wide | |
| 3. Nutritional : | | |
| Dermatitis | Territory wide | *Leucaena glauca* ingestion. |
| Plant poisoning (?) | New Guinea | |
| PARASITES :— | | |
| 1. Arthropod | | |
| *Amblyomma triguttatum* | New Guinea | |
| *Boophilus microplus* | Territory wide | |
| *Chrysomyia bezziana* | Territory wide | |
| *Chrysomyia megacephala* | Territory wide | |
| *Chrysomyia micropogon* | Territory wide | |
| *Gastrophilus* sp. | Papua, New Britain | Imported horses infected ; does not persist. |
| *Haemaphysalis* sp. | Territory wide | |
| *Ixodes* sp. | Papua | |
| *Musca vetustissima* | Territory wide | |
| *Sarcoptes scabiei* | New Britain | |
| *Stomoxys calcitrans* | Territory wide | |
| *Tabanus* sp. | Territory wide | |
| *Trombicula* sp. | New Britain | |
| 2. Nematode : | | |
| *Ascaris equorum* | Territory wide | |
| *Dictyocaulus arnfeldi* | New Guinea | |
| *Draschia megastoma* | New Britain | |
| *Gyalocephalus* sp. | Papua | |
| *Habronema microstoma* | New Britain, Bougainville | |
| *Habronema muscae* | New Guinea | |
| *Oxyuris equi* | Territory wide | |
| *Strongylus edentatus* | Territory wide | |
| *Strongylus equinus* | Territory wide | |
| *Strongylus vulgaris* | Territory wide | |
| *Trichonema* sp. | Territory wide | |
| *Triodontophorus serratus* | Territory wide | |
| *Triodontophorus* sp. | Papua | |

| PIG. | DISTRIBUTION | NOTES |
|---|---|---|
| DISEASES :— | | |
| 1. Virus : | | |
| Enzootic pneumonia | Territory wide | |
| 2. Bacterial : | | |
| Anthrax | Highlands Districts | Atypical type. |
| Erysipelas | Papua | |
| Pneumonia | Territory wide | *Pasteurella septica* Haemolytic *E. coli.* |
| 3. Spirochaetal : | | |
| Spirochaetal granuloma | Territory wide | |
| 4. Nutritional : | | |
| Hypocalcaemia | New Guinea | |
| Iron deficiency | Territory wide | |
| Vitamin A deficiency | Territory wide | |
| Zinc deficiency | Papua | |
| PARASITES :— | | |
| 1. Protozoan : | | |
| *Eimeria debliecki* | Territory wide | |
| *Eimeria scabra* | Papua | |
| *Eimeria* sp. | New Britain | |
| *Isospora suis* | Papua | |
| 2. Arthropod : | | |
| *Amblyomma* sp. | Papua, New Britain | |
| *Chrysomyia bezziana* | Territory wide | |
| *Haematopinus suis* | Territory wide | |
| *Sarcoptes scabiei* | Territory wide | |
| 3. Nematode : | | |
| *Ascarops dentata* | Territory wide | |
| *Ascarops strongylina* | Territory wide | |
| *Ascarops* sp. | New Britain | |
| *Ascaris lumbricoides suum* | Territory wide | |
| *Globocephalus urosubulatus* | New Guinea | |
| *Globocephalus* sp. | New Guinea, New Britain | |
| *Gnathostoma hispidum* | Territory wide | |
| *Gnathostoma* sp. | Territory wide | |

ANIMAL DISEASES AND PARASITES OF THE TERRITORY OF PAPUA AND NEW GUINEA.—*continued.*

| PIG.—*continued* | DISTRIBUTION | NOTES |
|---|---|---|
| *Macracanthorhynchus hirudinaceus* | Territory wide | |
| *Metastrongylus apri* .... | Territory wide | |
| *Metastrongylus pudendotectus* | Territory wide | |
| *Metastrongylus salmi* .... | Territory wide | |
| *Metastrongylus* sp. .... | Territory wide | |
| *Necator suillus* .... .... | New Guinea | |
| *Oesophagostomum dentatum* | Territory wide | |
| *Oesophagostomum quadrispinulatum* | Territory wide | |
| *Oesophagostomum* sp. .... | Territory wide | |
| *Physocephalus sexalatus* .... | Territory wide | |
| *Setaria congolensis* .... | Papua, New Guinea | |
| *Simondsia paradoxa* .... | Papua, New Guinea | |
| *Stephanurus dentatus* .... | Territory wide | |
| *Strongyloides* spp. .... | Territory wide | |
| *Trichuris trichiura* .... | Territory wide | |

## SHEEP

DISEASES :—

| | | |
|---|---|---|
| 1. Bacterial : | | |
| Caseous lymphadenitis .... | New Guinea | *C. ovis.* |
| Enterotoxaemia .... .... | New Guinea | |
| Foot abscess .... .... | New Guinea | |
| Mastitis .... .... .... | New Guinea | |
| Pneumonia .... .... | New Guinea | |

PARASITES :—

| | | |
|---|---|---|
| 1. Arthropod : | | |
| *Chrysomyia bezziana* .... | Papua, New Guinea | |
| *Chrysomyia rufifacies* .... | Papua | |
| *Damalinia ovis* .... .... | New Guinea | |
| *Oestrus ovis* .... .... | New Guinea | |
| *Sarcophagus* sp. .... .... | New Guinea | |
| *Stomoxys calcitrans* .... | New Guinea | |
| *Trombicula* sp. .... .... | New Guinea | |
| 2. Trematode : | | |
| *Fasciola hepatica* .... .... | New Guinea | |
| *Paramphistomum cotylophorum* | New Guinea | |
| 3. Cestode : | | |
| *Cysticercus tenuicollis* .... | New Guinea | |
| *Monieza expansa* .... .... | Papua, New Guinea | |

| SHEEP—*continued* | DISTRIBUTION | NOTES |
|---|---|---|
| 4. Nematode : | | |
| *Bunostomum trigonocephalum* | New Guinea | |
| *Bunostomum* sp. .... | New Guinea | |
| *Cooperia* sp. .... .... | New Guinea | |
| *Haemonchus contortus* .... | Papua, New Guinea | |
| *Nematodirus* sp. .... .... | Papua, New Guinea | |
| *Oesophagostomum columbianum* | Papua, New Guinea | |
| *Oesophagostomum* sp. .... | New Guinea | |
| *Ostertagia* sp. .... .... | New Guinea | |
| *Strongyloides papillosus* .... | New Guinea | |
| *Trichostrongylus colubriformis* | New Guinea | |
| *Trichuris globulosa* .... | New Guinea | |
| *Trichuris* sp. .... .... | New Guinea | |

The sheep population is centred mainly in the Highlands of the Territory of New Guinea.

## GOAT

DISEASES :—

| | | |
|---|---|---|
| 1. Bacterial : | | |
| Arthritis (PPLO) .... | Papua | |
| Mastitis .... .... | Territory wide | |
| 2. Nutritional : | | |
| Iodine deficiency .... | Territory wide | |

PARASITES :—

| | | |
|---|---|---|
| 1. Protozoan : | | |
| *Eimeria arloingi* .... | Papua | |
| *Eimeria faurei* .... | Papua | |
| *Eimeria intricata* | Papua | |
| *Eimeria parva* .... | Papua | |
| 2. Arthropod : | | |
| *Chrysomyia bezziana* .... | Territory wide | |
| *Damalinia caprae* .... | Territory wide | |
| *Linognathus stenopsis* .... | Territory wide | |
| 3. Trematode : | | |
| *Fasciola hepatica* .... | New Guinea | |
| 4. Cestode : | | |
| *Moniezia expansa* .... | Papua, New Guinea | |

| GOAT—*continued* | DISTRIBUTION | NOTES |
|---|---|---|
| 5. Nematode : | | |
| *Bunostomum trigonocephalum* | New Guinea | |
| *Bunostomum* sp. | Territory wide | |
| *Cooperia* sp. | Territory wide | |
| *Haemonchus contortus* | Territory wide | |
| *Nematodirus spathiger* | Papua | |
| *Nematodirus* sp. | Territory wide | |
| *Oesophagostomum asperum* | New Guinea | |
| *Oesophagostomum columbianum* | Territory wide | |
| *Oesophagostomum venulosum* | Territory wide | |
| *Strongyloides papillosus* | Territory wide | |
| *Trichostrongylus colubriformis* | New Guinea | |
| *Trichostrongylus* sp. | Territory wide | |
| *Trichuris globulosa* | Territory wide | |
| *Trichuris ovis* | Papua | |
| *Trichuris* sp. | Territory wide | |

## POULTRY

DISEASES :—

| | | |
|---|---|---|
| 1. Virus : | | |
| Fowl pox | Territory wide | |
| Visceral leucosis | Territory wide | |
| Neurolymphomatosis | Territory wide | |
| 2. Bacterial : | | |
| Botulism | Papua, New Guinea | |
| Coryza | Papua | |
| Chronic Respiratory Disease (PPLO) | New Guinea | |
| Pasteurellosis | Papua | |
| Pullorum disease | Territory wide | |
| 3. Fungal : | | |
| Aspergillosis | Territory wide | |
| 4. Nutritional : | | |
| Manganese deficiency | Papua | |
| Vitamin A deficiency | Territory wide | |
| Vitamin B6 deficiency | Territory wide | |
| Zinc deficiency | Papua | |

PARASITES :—

| | | |
|---|---|---|
| 1. Protozoan : | | |
| *Eimeria acervulina* | Territory wide | |
| *Eimeria maxima* | Territory wide | |
| *Eimeria mitis* | Territory wide | |
| *Eimeria necatrix* | Territory wide | |
| *Eimeria tenella* | Territory wide | |
| 2. Arthropod : | | |
| *Cnemidocoptes mutans* | Territory wide | |
| *Cytoleichus nudus* | New Guinea | |
| *Goniocotes gallinae* | Papua | |
| *Goniodes dissimilis* | Territory wide | |
| *Lipeurus caponis* | Territory wide | |
| *Liponyssus gallinae* | Territory wide | |
| *Megninia cutitalis* | Papua | |
| *Menopon gallinae* | Territory wide | |
| 3. Trematode : | | |
| *Cotylurus cornutus* | Papua | Recorded from duck. |
| *Echinoparyphium paraulum* | Papua | Recorded from duck. |
| *Echinoparyphium recurvatum* | Papua | Recorded from duck. |
| *Echinostomma recolutum* | Papua | Recorded from duck. |
| *Hypoderaeum conoideum* | Papua | Recorded from duck. |
| *Notocotylus atenuatus* | Papua | Recorded from duck. |
| *Strigea gracilus* | Papua | Recorded from duck. |
| 4. Cestode : | | |
| *Davainea proglottina* | Territory wide | |
| *Hymenolepsis lanceolata* | Papua | Recorded from duck. |
| *Raillietina cesticillus* | New Britain | |
| *Raillietina echinobothrida* | Territory wide | |
| *Raillietina tetragona* | Papua | |
| *Raillietina* sp. | Territory wide | |
| 5. Nematode : | | |
| *Acuaria spiralis* | Territory wide | |
| *Ascaridia columbae* | New Britain | Recorded from pigeon. |
| *Ascaridia galli* | Territory wide | |
| *Capillaria columbae* | Territory wide | |
| *Capillaria longicollis* | Papua | Recorded from pigeon. |
| *Capillaria* sp. | Territory wide | |
| *Heterakis gallinae* | Territory wide | |
| *Ornithostrongylus quadriradiatus* | Papua | Recorded from pigeon. |
| *Oxyspirura mansoni* | Territory wide | |
| *Tetrameres* sp. | Territory wide | |
| *Trichostrongylus tenuis* | Papua | |

ANIMAL DISEASES AND PARASITES OF THE TERRITORY OF PAPUA AND NEW GUINEA.—*continued.*

| DOG | DISTRIBUTION | NOTES |
|---|---|---|
| DISEASES :— | | |
| 1. Virus : | | |
| Distemper | Territory wide | |
| Infectious Canine Hepatitis | Papua | Clinical diagnosis—one case. |
| Papillomatosis | Territory wide | |
| Venereal granuloma | Territory wide | |
| 2. Bacterial : | | |
| Abscess | Territory wide | |
| Pneumonia | Territory wide | |
| Tetanus | Papua | |
| 3. Nutritional : | | |
| Vitamin D deficiency | Territory wide | |
| PARASITES :— | | |
| 1. Arthropod : | | |
| *Chrysomyia bezziana* | Territory wide | |
| *Ctenocephalides canis* | Territory wide | |
| *Ctenocephalides felis* | Papua | |
| *Demodex folliculorum* var. *canis* | Territory wide | |
| *Heterodoxus longitarsus* | Papua | |
| *Ixodes* sp. | New Guinea | |
| *Otodectes cynotis* | Territory wide | |
| *Rhipicephalus sanguineus* | Territory wide | |
| *Sarcoptes scabiei* | Territory wide | |
| *Trichodectes canis* | Papua | |
| 2. Cestode : | | |
| *Dipylidium caninum* | Territory wide | |
| 3. Nematode : | | |
| *Ancylostoma caninum* | Territory wide | |
| *Ancylostoma* sp. | Territory wide | |
| *Dirofilaria immitis* | Territory wide | |
| *Spirocerca lupi* | Papua | |
| *Toxocara canis* | Territory wide | |
| *Trichuris vulpis* | Papua | |

| CAT | DISTRIBUTION | NOTES |
|---|---|---|
| DISEASES :— | | |
| 1. Virus : | | |
| Infectious pneumo-enteritis (Panleucopenia) | Territory wide | |
| 2. Nutritional : | | |
| Vitamin D deficiency | Territory wide | |
| PARASITES :— | | |
| 1. Arthropod : | | |
| *Chrysomyia bezziana* | Territory wide | |
| *Ctenocephalides felis* | Territory wide | |
| *Felicola subrostrata* | Papua | |
| *Otodectes cynotis* | Territory wide | |
| 2. Cestode : | | |
| *Diphyllobothrium erinacei* | Territory wide | |
| *Dipylidium caninum* | Papua | |
| *Mesocetoides* sp. | Papua | |
| *Taenia taeniaformis* | Territory wide | |
| 3. Nematode : | | |
| *Ancylostoma braziliense* | Territory wide | |
| *Ancylostoma caninum* | Territory wide | |
| *Dirofilaria immitis* | Papua | |
| *Toxocara* sp. | Territory wide | |

The foregoing list has been compiled from records at the Veterinary Laboratory, Kila Kila, and reports from field veterinary officers of the Division of Animal Industry. Papua refers to the Territory of Papua, including Central, Milne Bay, Northern, Gulf and Western Districts. New Guinea refers to the New Guinea mainland, including Morobe, Madang, Sepik, Eastern Highlands and Western Highlands and Southern Highlands District of Papua. New Britain refers to New Guinea Islands region, including New Britain, Bougainville, New Ireland and Manus Districts.

# Notes on the Distribution and Economic Importance of the Papuan Tip-wilt Bug, Amblypelta lutescens papuensis Brown. (Heteroptera : Coreidae)

J. J. H. Szent-Ivany * and A. Catley †

*In this paper data on the distribution and host plants of the "Papuan Tip-wilt Bug"* [1] (Amblypelta lutescens papuensis), *the Papuan subspecies of* A. lutescens *Dist., are presented. Observations on the feeding habits and damage to economic plants are described and three different egg parasites of the insect are recorded.*

VERY little was known about the genus *Amblypelta* Stal. in the Territory of Papua and New Guinea before the year 1958. In 1958 E. S. Brown (Commonwealth Institute of Entomology, London) published two papers on the genus, one on the taxonomy (Brown 1958) and one on the feeding habits and host plants (Brown 1958a). Of 12 species recorded in Brown's genus revision, six occur in the Territory of Papua and New Guinea. Some of these are indigenous species, the others are described earlier from other countries and they have subspecies in Papua and New Guinea. These are : *Amblypelta lutescens papuensis* Brown, *A. ardleyi* Brown, *A. theobromae* Brown, *A. cocophaga cocophaga* China, *A. costalis szentivanyi* Brown and *A. gallegonis bougainvillensis* Brown. All except *Amblypelta cocophaga cocophaga* China were described in Brown's abovementioned paper as new species or new subspecies (Brown 1958).

*Amblypelta lutescens papuensis* Brown (Fig. I) is a purely Papuan insect. It has never been found in the Territory of New Guinea. The name form (*A. lutescens lutescens* Dist.) was recorded by Brown (1958) from various parts of Queensland, the Northern Territory of Australia, Murray Island, Banks Island (Torres Strait), Kai Island, Timor and Wetter Islands. Host plants of *Amblypelta lutescens lutescens* (Dist.) recorded by Brown (1958a) are : *Ananas comosus* (pineapple), *Annona squamosa* (custard apple), *Carica papaya* (papaw), *Calpidia brunoiana, Citrus* sp., *Cocos nucifera* (coconut), *Ficus* sp., *Gossypium* sp. (cotton), *Guoia semiglauca, Macadamia ternifolia* (Queensland nut), *Mangifera indica* (mango), *Manihot utilissima* (cassava, quoted as *M. esculenta*), *Melia dubia* (white cedar), *Musa paradisiaca* (banana), *Passiflora edulis* (passion-

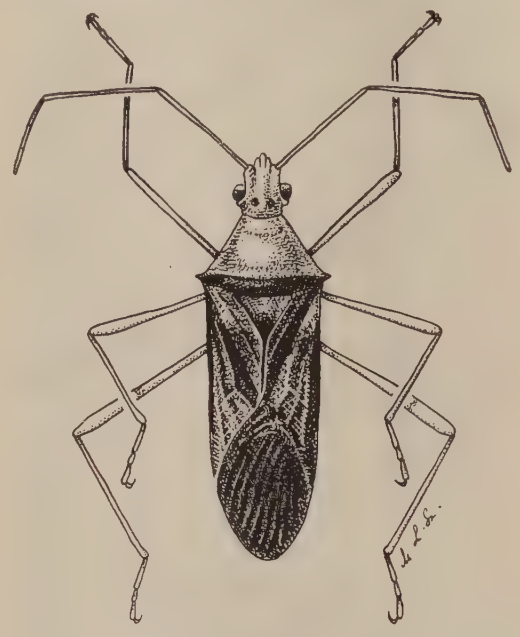

Fig. I.—*Papuan Tip-wilt Bug* (*Amblypelta lutescens papuensis* Brown) (*x* 2½).

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[1] This common name is proposed for *Amblypelta lutescens papuensis* Brown since the Papuan subspecies is more important as a pest of the stems, causing tip-wilt, than as a pest of fruits, as is the case with the name form (*Amblypelta lutescens lutescens* Dist.) from Australia, which is known as the "Fruit-spotting Bug".

(Manuscript received on 12th July, 1960.)

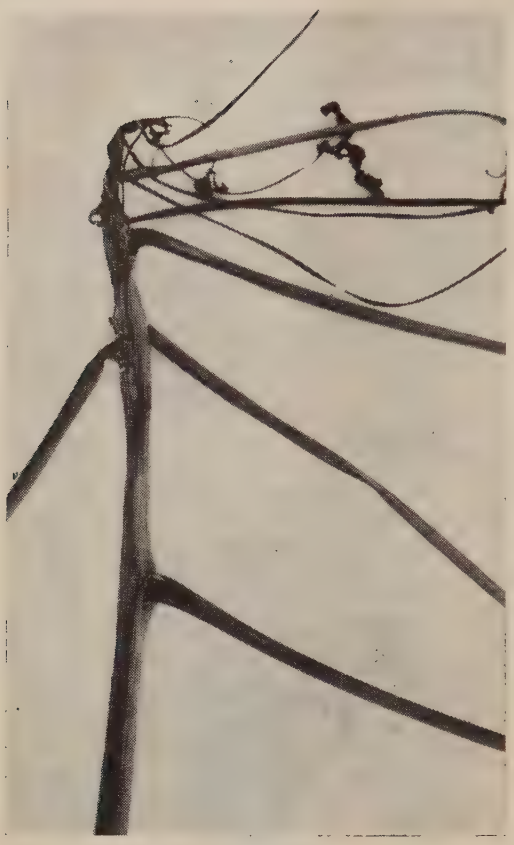

PLATE I.
(*Photo : R. T. Simon Thomas.*)

fruit), *P. quadrangularis* (grenadilla), *P. suberosa* (corky passionfruit), *P. subpeltata* (white passion flower), *Peltophorum pterocarpum, Plumeria* sp. (frangipani) and *Xanthium strumarium,* representing not less than 18 plant families. Brimblecombe (1948, p. 206) records *Pisonia brunoniana, Peltophorum pterocarpum* (quoted as *P. ferrugineum*), *Guoia semiglauca,* "white cedar", "rough leaf fig" and "orange box wood" as indigenous host plants of *Amblypelta lutescens lutescens* (Dist.) in Queensland.

*Amblypelta lutescens papuensis* Brown has not been recorded from as many host plants. Brown recorded it from *Hevea brasiliensis* (rubber), *Manihot utilissima* (cassava, mentioned as *M. esculenta*), *Phaseolus mungo* (mungo bean) and *"Uremia lobata".* Further host plant records in Papua are *Abroma augusta* (devil's cotton), *Carica papaya* (papaw), *Ipomoea batatas* (sweet potato), *Mangifera indica* (mango), *Plumeria acutifolia* (frangipani) and *Sechium edule* (choko) (Szent-Ivany, 1958, pp. 424, 425).

Since the publication of the senior author's paper, it has been found that *Amblypelta lutescens papuensis* Brown is able to cause similar damage to *Cocos nucifera* to that of *Amblypelta cocophaga,* a serious pest of coconuts in the British Solomon Islands, the result of the injury being premature fall of nuts. Nutfall apparently caused by this species was observed in three districts of Papua, namely in the Gulf District (Petoi village area), the Central District (Aroa and Baubauguina Estates) and in the Milne Bay District (Doini, Puni Puni and Sewaitaitai Plantations). Live adults of *Amblypelta lutescens papuensis* Brown placed in breeding jars with parts of coconut inflorescence were observed feeding on "button nuts" by E. Cleland, G. S. Dun, J. L. Gressitt and the senior author at Aroa Estate in September-October, 1958. After a few hours the nuts, attacked in the jars, began

PLATE 2.
(*Photo : R. T. Simon Thomas.*)

PLATE 3.

(*Photo : J. J. H. Szent-Ivany.*)

to show the typical scars of *Amblypelta* damage, as shown in the publications of Brown (1959), Plate II, Fig. 1 and Phillips (1940), Plate XIII, Fig. 2. B. E. Fairfax-Ross, B. G. Griffiths and the junior author observed *Amblypelta lutescens papuensis* feeding at Baubauguina Estate on the nuts of dwarf coconut palms about five feet above the ground. (April, 1959.) There is a marked correlation between certain ant species (particularly *Anoplolepis longipes* Jerd. and *Oecophylla smaragdina* F.) and the damage by *Amblypelta lutescens papuensis* in coconut plantations. Observations on this by the entomologists of the Department of Agriculture (Port Moresby) and particularly by the junior author, are in progress.[2]

At the time when E. S. Brown visited Papua (1956), very little was known of the injury caused by *Amblypelta lutescens papuensis* to rubber (*Hevea brasiliensis*). In his paper Brown (1958a) reports : " In certain cases, however, little or no damage results from feeding on shoots ; this was the case in New Guinea with *A. lutescens papuensis* Brown (Brown 1958, p. 519) and *A. costalis szentivanyi* on rubber." The first observations were made by Mr. A. Himson, Mrs. P. Himson and the senior author in the nurseries of Bisianumu Rubber Experiment Station (Sogeri Subdistrict of the Central District of Papua) in August, 1957. Adults and nymphs of *Amblypelta lutescens papuensis* were observed feeding on the stems of rubber seedlings and buddings, a few inches under the growing point, the symptoms of injury being peculiar longitudinal scars and severe tip-wilt.

The symptoms of damage on the young, fresh, green *Hevea* buddings and seedlings are different from the injury found on older ones, which have formed a more compact woody cortex. As a result of *Amblypelta* attack, longitudinal grooves appear on the tender, green upper portion of the young stems. (Plate 1.) This is followed by tip-wilt. The leaves on the branches, near the growing point begin to wilt and droop, they fall and some of the branches die. (Plates 2-4.) The buddings and seedlings usually survive, but they suffer a serious setback to growth, especially if the same budding is repeatedly injured.

Reddish brown longitudinal scars, pointed on both ends, with a dark spot or a short groove in their centre, are the first signs of *Amblypelta*

PLATE 4.

(*Photo : J. J. H. Szent-Ivany.*)

[2] At a later date the junior author intends to write a comprehensive paper on the ant and *Amblypelta* complex in plantations and on the biology, ecology and economic importance of all species of the genus *Amblypelta* Stal. in the Territory of Papua and New Guinea.

PLATE 5.
(*Photo : J. J. H. Szent-Ivany.*)

*lutescens* injury on older buddings. (Plate 5.) These look very similar to the scars found on the bases of young coconuts (under the calyx) in an *Amblypelta* nut-fall area. Later the scars grow bigger, their colour turns dirty whitish grey, keeping the original reddish brown colour on their rims. If there is a large number of them on the cortex, the surface of the stem becomes knotty and distorted. (Plates 6, 7.) On one of the severely damaged buddings at Bisianumu Nursery, latex was exuding near the growing point. (Plate 8.) A portion of the stem of a rubber seedling with a feeding adult of *Amblypelta lutescens papuensis* Brown is shown in Plate 9.

How serious and widespread the damage by *Amblypelta* to *Hevea brasiliensis* can be is shown by the observation of the senior author in August, 1957. In a small nursery block 111 of the 140 stubbed buddings had typical *Amblypelta* injury and specimens of *Amblypelta lutescens papuensis* were found on 85 buddings. In a block of 100 acres of young rubber in the Central District of Papua nearly every seedling was attacked by *Amblypelta lutescens papuensis* in May, 1958. The height of the seedlings was five to seven feet. These two and other observations showed that *Amblypelta lutescens papuensis* Brown does not occur in pockets as cacao mirids ("capsids") do, but they are fairly evenly distributed in the plantations. This applies also to *Amblypelta theobromae* Brown in the Northern District of Papua.

PLATE 6.
(*Photo : R. T. Simon Thomas.*)

Fortunately, *Amblypelta lutescens papuensis* is susceptible to chlorinated hydrocarbon insecticides, particularly Dieldrin, in the form of 0,2-0,3 per cent. emulsion sprays, and rubber seedlings are usually not attacked when they exceed six to seven feet in height. Thus chemical control can be achieved by hand-operated and portable power-spraying machines.

In addition to the injury to the earlier recorded garden plants (frangipani, papaw, choko) (Szent-Ivany, 1959), *Ipomoea carnea* and *Abelmoschus manihot* (aibika, "native cabbage") were recently found severely attacked by *Amblypelta lutescens papuensis* Brown in a garden in the Port Moresby suburb of Boroko. In the case of *A. manihot* the injury was caused by adults and all instar neanides to the top four to six inches of the stem. The symptoms of the damage are somewhat similar to those caused by the Papuan Tip-wilt Bug on papaw : irregular scars and cracks on the stem. (Brown, 1958a, p. 547.)

A few natural enemies of *Amblypelta lutescens papuensis* were found, all of them being egg parasites. The first egg parasites found by E. Cleland, F. J. Simmonds and the senior author at Aroa Plantation (eggs laid on the leaves of *Manihot utilissima*) represented a species of the genus *Hadronotus* (Hymenoptera: Scelionidae). (Simmonds, 1960a, p. 50.) Many more specimens of this species were bred from the eggs found on the lower and upper surface of the leaves of *Ipomoea carnea* by the senior author at Boroko (Port Moresby). Four eggs produced the eupelmid *Anastatus* sp. A third species, the encyrtid *Oenocyrtus* sp., was bred from eggs collected by J. Cronan, the senior and junior authors on leaves of *Hevea* seedlings in a nursery at Mororo Estate (Sogeri Subdistrict, Central District of Papua). None of these parasites proved to be efficient in controlling *Amblypelta lutescens papuensis* or in keeping their population density below a level when they are of no economic importance. Even in the ornamental garden at Boroko where a relatively large percentage of *Amblypelta* eggs was parasitized (by *Hadronotus* sp. and *Anastatus* sp.) *Ipomoea carnea* (an ornamental often planted as "hedge-plant" in Port Moresby home gardens) was severely damaged by *Amblypelta.*

PLATE 7.
(*Photo* : *R. T. Simon Thomas.*)

The following is a complete list of localities where *Amblypelta lutescens papuensis* Brown was found in the Territory of Papua, the geographical names being listed in alphabetical order within the districts :[3]

Gulf District : Cupola Estate (Sz.I.), Karaita Village, Kerema, Murua Agricultural Station, Petoi Village. (Sz.I.)

[3] Localities earlier recorded by E. S. Brown (1958)—"B". Those by Szent-Ivany (1959)—"Sz.I.".

Central District : Aroa Estate (Sz.I.), Baubauguina Estate, Bisianumu Rubber Experiment Station (B., Sz.I.), Brown River (25 miles north of Port Moresby) (B., Sz.I.), Daradai Plantation (Sz.I.), Doa Estate (Sz.I.), 14-mile Farm, Itikinumu Plantation (this is the plantation where *Amblypelta lutescens papuensis* damage was observed first by Mr. B. E. Fairfax-Ross and Mr. J. Grimmer, but at that time there was no evidence that the injury was caused by the Papuan Tip-Wilt Bug), Kanosia Estate, Laloki Quarantine and Plant Introduction Station (Sz.I.), Lolorua Estate (Sz.I.), Maraboi Estate, Ninoa Estate, Port Moresby (Boroko, Konedobu) (Sz.I.), Subitana Estate, Veimauri Plantation.

Milne Bay District : Kuiaro (near Samarai) (B.).

Northern District : Mount Lamington, 1,400-1,500 ft. (B.).

The specimens taken at the above-mentioned localities were collected by E. S. Brown, W. E. Casey, A. Catley, E. Cleland, W. Cottrell-Dormer, J. Cronan, G. S. Dun, B. E. Fairfax-Ross, B. G. Griffiths, A. Himson, E. Kanjiri, C. T. McNamara, F. Mollinger, F. X. Ryan, F. J. Simmonds, J. J. H. Szent-Ivany, M. L. Szent-Ivany and W. A. Van den Berk.

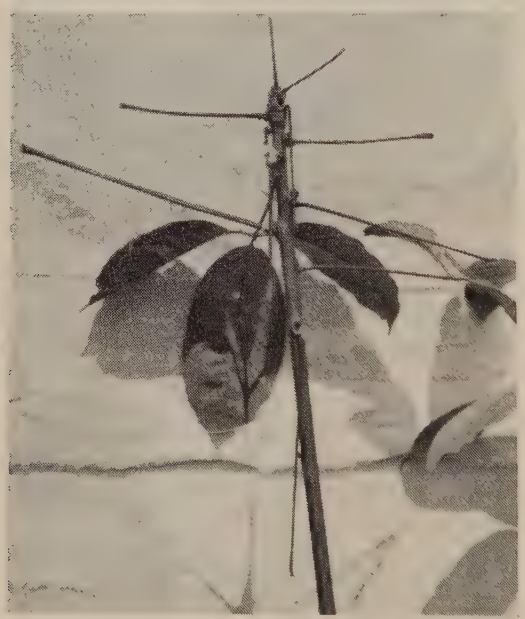

PLATE 8.

(*Photo : J. J. H. Szent-Ivany.*)

PLATE 9.

(*Photo : R. T. Simon Thomas.*)

## ACKNOWLEDGEMENTS

Appreciation is expressed to Mr. E. S. Brown, Dr. M. S. K. Ghauri (Commonwealth Institute of Entomology, London) and Mr. G. E. J. Nixon (British Museum, London) for the identification of specimens ; also to Mr. E. S. Brown for his technical advice on various aspects of *Amblypelta* research, to Mr. B. E. Fairfax-Ross, the general manager of British New Guinea Development Company Plantations, for first drawing the attention of the Department of Agriculture, Stock and Fisheries to the symptoms of *Amblypelta* damage to rubber seedlings, to Mr. A. Burrows for supplying damaged rubber seedlings from Doa Estate (British New Guinea Development Company) (Figs. 2, 3, 7, 8), to Mr. E. Cleland, Manager of Aroa Estate (British New Guinea Development Company), for his helpful assistance in collecting and carrying out cage experiments, to Dr. F. J. Simmonds, Director of the Commonwealth Institute of Biological Control, for his advice on collecting egg parasites, to Mr. R. T. Simon Thomas, Entomologist with the Department of Economic Affairs (Hollandia, Netherlands New Guinea), for some of the photographs, to Mrs. M. L. Szent-Ivany for the drawing of Fig. 1 and to all those who collected specimens and eggs of *Amblypelta lutescens papuensis* (see the names in the previous paragraph), particularly to Mr. W. E. Casey (Popondetta), former rubber inspector with the Department of Agriculture, who collected a large number of specimens in various plantations and gave a lot of valuable information.

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# HERBICIDAL CONTROL OF RAIN FOREST REGROWTH

J. M. Richardson

*The use of modern herbicides to control jungle regrowth offers an attractive solution to a major problem in tropical high-rainfall areas. The Australian Army asked the Department of Agriculture, Stock and Fisheries of the Territory of Papua and New Guinea to test a number of herbicides under field conditions. The author, formerly agronomist at the Lowlands Agricultural Experiment Station, Keravat, laid down test plots for various substances. His conclusion is that certain herbicides do offer possibilities for long-term weed control, but the extremely high cost involved would limit their use mainly to highly-specialized areas.*

AN experiment to assess the effectiveness of various herbicides against encroaching weeds on land cleared of rain-forest was laid down during April, 1958. The main object of the trial was to determine whether regrowth and invading weeds appearing after clearing of rain-forest areas for the construction of airfields, military installations, industrial sites and so on, could be controlled by the application of chemicals. The herbicides chosen are relatively safe to use and are not a fire hazard.

The trial area was first cleared of primary bush during 1953. The resulting secondary growth was felled and burnt in late 1957 and the test plots, 20 feet square, with three-foot strips between plots, were marked out. During April, 1958, the plots were topped to two feet high, or scalped to two inches high, depending on the treatment to be applied.

The herbicides used and their rates of application per plot of 400 square feet were :—

| | |
|---|---|
| Polybor Chlorate .... .... | 32, 16, 8 lb. |
| Concentrated Borascu .... | 80, 40, 20 lb. |
| Ureabor .... .... .... | 14, 7, 3½ lb. |
| Ammate .... .... .... | 16, 8, 4 lb. |
| T.C.A. .... .... .... | 6, 3, 1½ lb. |
| C.M.U. .... .... .... | 2, 1, ½ lb. |

Ureabor and Concentrated Borascu were applied dry. T.C.A. was applied as a solution and C.M.U. as a suspension, in water, through a watering can. Polybor chlorate and Ammate were applied in solution through a knapsack sprayer. The Ammate and Polybor Chlorate were applied to "topped" plots, and the others to "scalped" plots (where the chemicals were required to be applied in solution or suspension, three gallons of water per plot were used. Three gallons were found to be sufficient to give an even cover over the 400-square-foot plot). Each treatment had two replications and two "scalped" and two "topped" untreated pilots were included.

The dominant species on the trial area at the time of application of the herbicides were kunai grass (*Imperata cylindrica*), couch grass (*Cynodon dactylon*), two other grass species (*Paspalum and Sorghum*), bracken fern (*Pteridium* sp.), *Passiflora* sp., a Solanaceous shrub and several tree species (the burning of the trial area reduced the tree density as compared with the surrounding secondary bush, but some trees survived the burning and some tree seedlings have since appeared on some of the experimental plots).

The total rainfall for the six months of the trial period of 3,911 points was well distributed, with rain falling on 84 days of the 176 days of the trial period. The average daily maximum and minimum temperatures in degrees Fahrenheit were :—

| | Maximum | Minimum |
|---|---|---|
| April .... .... | 88 | 72 |
| May .... .... | 88 | 72 |
| June .... .... | 88 | 71 |
| July .... .... | 84 | 71 |
| August .... .... | 86 | 71 |
| September .... | 89 | 71 |

PLATE 1.—*Herbicide applications at three days, six weeks and six months.* (*A*) *Polybor Chlorate, medium rate*; (*B*) *Concentrated Borascu, medium rate*; (*C*) *Ureabor, medium rate.*

Observations of the effects of the herbicides were made three days, one week, two weeks, four weeks, six weeks, 12 weeks and six months after the application of the herbicides.

## EFFECTS OF THE HERBICIDES

*Polybor Chlorate*

Polybor Chlorate showed a rapid and severe effect, particularly at the medium and high rates of application. However, regrowth commenced after three to four weeks and even though the herbicide was still active after eight weeks the low- and medium-rate plots were re-invaded by weeds. After three months, there was a little regrowth on the high-rate plots. After six months, the control of weeds on all the Polybor chlorate plots was poor.

*Concentrated Borascu*

The initial effect was slower than for Polybor Chlorate, but after three months the herbicide was still active, particularly on the medium- and high-rate plots. At the low rate of application there was a large amount of regrowth after four weeks and even though the kunai regrowth became scorched there was a dense population of weeds after three months. There was little regrowth on the medium- and high-rate plots after three months, but after six months the weed control was only fair.

*Ureabor*

The initial effect was not severe, and regrowth was apparent on all plots after four weeks. However, this regrowth was weak and the herbicide was still active. At three months the overall effect was similar to that shown by Concentrated Borascu, but generally the effect was more severe. At nine months the weed control on the high-rate plots was very good, on the medium-rate plots fair and on the low-rate plots poor.

PLATE 2.—*Herbicide applications at three days, six weeks and six months. (A) Ammate, medium rate : (B) C.M.U., medium rate ; (C) T.C.A., medium rate.*

*Ammate*

There was a rapid and severe effect, particularly at the medium and high rates of application. After three months, regrowth on the low-rate plots had reached a density comparable with that of the control plots and there was a large amount of regrowth on the medium- and high-rate plots. After six months the weed control on all plots was very poor.

*C.M.U.*

At all rates of application, the initial effect was slow, with some regrowth appearing at four weeks. However, the herbicide was still active and the regrowth was weak on all plots six weeks after application. After three months, the weed control on all plots was very good with very little regrowth. After six months the weed control on the medium- and high-rate plots was still very good.

*T.C.A.*

The initial effect was rapid, but some regrowth appeared on all plots four weeks after application of the herbicide. The regrowth increased rapidly on the low- and medium-rate plots and after three months there was a dense weed cover. At the high rate, the weed cover was not dense but was vigorous. After six months the weed control on the high-rate plots was fair and on the medium- and low rate plots poor.

## Conclusions

Polybor Chlorate, Ammate and T.C.A. were not persistent. Concentrated Borascu gave only fair control. Ureabor, at the high rate of application and C.M.U. at high and medium rates have all proved persistent and given very good weed control for the six-month trial period. It is possible that Ureabor, at the medium rate of

PLATE 3.—*Control area during tests, at three days, six weeks and six months after commencement of trial. This area had been scalped at the start of the tests.*

application, and C.M.U. at the low rate of application, followed by spot treatments of regrowth would prove as effective as, and more economical than, the higher rates of application.

## TECHNICAL INFORMATION ON HERBICIDES

*Polybor Chlorate*

A general weedkiller, usually applied in solution through a sprayer or watering can. This weedkiller contains :—

Sodium Pentaborate, 58 per cent.

Sodium Tetraborate, 15 per cent.

Sodium Chlorate, 25 per cent.

Spreading Agent, 2 per cent.

This herbicide is non-selective (i.e., it is toxic to all vegetation), it is fast-acting and has a residual effect at high rates of application.

*Concentrated Borascu*

A general weedkiller which is applied dry, by hand, or by use of a mechanical spreader. It is a sodium borate ore. It is toxic to all vegetation and has a marked residual effect, particularly at high rates of application.

*Ureabor*

A general weedkiller which is applied dry, by hand, or by use of a mechanical spreader. It is a granular complex of sodium borates and substituted urea (3-p-chlorophenyl, 1-1, dimethylurea). It is toxic to all vegetation and has a marked residual effect.

*Ammate*

This is a non-selective weed and brush killer containing 80 per cent. ammonium sulphate and 20 per cent. inert ingredients. It is soluble in water and is usually applied to vegetation as a spray. It gives a rapid kill when applied at recommended concentrations, but has limited persistence as a soil sterilizer.

*T.C.A.*

This chemical (trichloroacetic acid) is sold commercially (as the sodium salt) under various names. At high rates of application it acts as a soil sterilizer, but it is readily leached from the soil and under high-rainfall conditions it is not markedly persistent.

*C.M.U.* [or Monuron—3-(p-chlorophenyl) -1, 1,-dimethylurea.]

This chemical is one of a range of highly phytotoxic, persistent herbicides, known as the substituted ureas. It is only sparingly soluble in water and is normally applied as a fine powder suspension.

### *Treatment costs*

Approximate Costs per Acre at Medium Rate.

| | |
|---|---|
| Polybor Chlorate .... .... .... | £130 |
| Concentrated Borascu .... .... | £127 |
| Ureabor .... .... .... | Not known |
| Ammate .... .... .... .... | £152 |
| T.C.A. .... .... .... .... | £65 |
| C.M.U. .... .... .... .... | £218 |

These costs are based on figures supplied by distributors of the herbicides used in the trial. The costs per acre are very high, but it must be borne in mind that these herbicides are generally applied " intensively " to control weeds for uses such as to reduce fire risks, to allow for more efficient use of storage space, or to clear road verges and so increase the visibility of vehicle drivers.

# Observations on the biology of the Black Leaf-footed Bug Leptoglossus australis (F.) (Heteroptera, Coreidae) in the Territory of Papua and New Guinea

J. J. H. Szent-Ivany * and A. Catley †

Leptoglossus australis (*F.*) *is closely related to the "Passion-Bug" of Queensland* (Leptoglossus bidentatis *Montr.*) *and it is a widely distributed common species, not only in the Territory of Papua and New Guinea but also on many smaller islands of the South Pacific Region. It also occurs in Northern Australia. As a pest of various cultivated plants,* Leptoglossus australis (*F.*) *has some economic importance. By New Guinea planters, orchardists, and horticulturists it is often referred to as the "Passion-Bug". However, so that* Leptoglossus australis (*F.*) *will not be mistaken for the near-related* L. bidentatus *Montr., the authors suggest giving the former the common name, "Black Leaf-footed Bug". The name "Leaf-footed Bug" is often used to describe coreids with flattened and expanded tibiae of the hind legs.* (*Wolcott,* 1948.)

*Leptoglossus* has species in four continents. China (1930) in a table showing the geographical distribution of the genus lists one species from Polynesia, two from the "Oriental-Australian Region", one each from the Philippines, Indo-China, India, Ceylon and the Ethiopian Region, one from the Seychelles, and Mascarene, nine from the Nearctic, 28 from the Neotropical Region and one from the Chilean region.

*L. membranaceus* (F.), near related to *L. australis* (F.), has a very wide area of distribution. It occurs in most tropical Asian countries and in many parts of Africa. (Tillyard, 1927.) Dr. M. S. K. Ghauri (Commonwealth Institute of Entomology, London) has kindly informed the authors (in litt. 25th January, 1960) that in the collection of the British Museum there are representatives of this species from the folowing areas : "Southern Rhodesia, West Africa, Ghana, Mauritius, Southern Nigeria, Malayan Peninsula, Luzan, Mahe, East Africa, Gaza Land, Ceylon, India, Assam, Philippine Islands, Longo-ma-Lobah, Tenass Vall Myitta, Kavala Islands and Rodriguez Islands."

Essig (1947) records nine species of *Leptoglossus* from North America, the commonest three being *L. zonatus* (Dallas), known under the common name of "Western Leaf-footed Bug", *L. phyllopus* (L.), recorded as a foliage pest of potato (Metcalf & Flint, 1939), and *L. oppositus* (Say). P. Lepesme (1947) records *Leptoglossus zonatus* as a pest of date palm, cedrat fruit and melon in California.

Wolcott (1948) mentions three species from Puerto Rico. These are *Leptoglossus gonagra* (F.), pest of squash, oranges, grapefruit, guava, pumpkin and corn, *L. stigma* (Herbst.), pest of guava and *Bixa orellana,* and *L. balteatus* (L.), pest of guava.

*Leptoglossus australis* was described by Fabricius in 1775 as *Cimex australis.* Dr. W. E. China (1930) recorded this species from Apia and Mulifauna in Samoa. He mentioned also that the species was recorded from the New Hebrides, New Caledonia, Fiji, Tahiti and Bora Bora. It is a typical fauna element of the Australian Zoo-geographical Region, which includes the Papuan Subregion.

*Leptoglossus australis* has a wide range of host plants in the Territory of Papua and New Guinea. Twenty-six plant species are recorded

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in this paper, representing 15 families, but severe damage is caused only to certain species of Cucurbitaceae, Myrtaceae, Passifloraceae and Rutaceae.

In appearance, *Leptoglossus australis* (F.) is most striking, being about three-quarters of an inch in length and smoky black in colour. The black colour is interrupted by a prominent orange to red band across the anterior margin of the pronotum. The underside of the body is black and spotted with the same orange to red colour. The hind legs are particularly long with the tibiae flattened and toothed, giving the insect a bizarre appearance. (See Figures I and II).

## LIFE HISTORY

Breeding experiments carried out by the junior author in the entomological laboratory of Agricultural Experiment Station, Bubia (near Lae, Morobe District of New Guinea) had the following results :—

FIG. I.—Black Leaf-footed Bug [*Leptoglossus australis* (F.)] Adult. (x 2½).

FIG. II.—Black Leaf-footed Bug [*Leptoglossus australis* (F.)] Ventral Surface. (Legs and antennae omitted.) (About x 3½.)

The eggs were found to be pale brown coloured and measured about 1.6 mm. long and about 1.0 mm. broad. (See Fig. III*a*.) They are barrel-shaped and are usually laid in chains on the underside of the creeping stems of Cucurbitaceae and Passifloraceae. (See Fig. III*b*.) In the laboratory, females have laid up to 32 eggs in one chain but in the field the numbers laid are usually much smaller, probably because the insect is more likely to be interrupted in the process. If a suitable oviposition site is unavailable, the female will oviposit on a flat surface or even a dead twig.

In the laboratory, adults were held successfully on *Momordica Charantia* (Cucurbitaceae) cuttings in water and they readily oviposited on this plant. When laying eggs, the female first selects a suitable site and then hangs upside down from the stem and slowly moves along it, depositing each egg singly as she progresses. Each egg is affixed to the stem by a secretion from paired accessory glands which open into the distal portion of the vagina. This cement-like secretion is smeared on to the substrate before the extrusion of each egg, which is then

held in place by the tip of the abdomen, until the secretion hardens. The time taken for each egg to be laid is just under one minute.

The incubation period for the eggs is about nine days but it varies from eight to ten. The eggs in each batch generally hatch within minutes of one another. At eclosion, the nymph (neanide) pushes back the operculum of the egg and emerges headfirst. The head and thorax are first extruded, followed by antennae and legs, with the abdomen last to appear. The operculum may be pushed off completely or it may be left suspended by a flap on its rim.

*L. australis* passes through five stages (instars) before the adult emerges and when each instar is fully developed the insect passes to its next phase of development by shedding its skin. The length of each instar varies considerably according to food and environmental conditions but the length of the first instar is generally constant at about three days and during this period the neanide feeds very little and often not

FIG. III.—(*a*) *Magnified egg of* Leptoglossus australis (*F.*) (*x* 8). (*b*) *Chain of eggs of* Leptoglossus australis (*F.*) (*Slightly enlarged*).

at all. The moulting period, like hatching, is a very critical time for the insect and sometimes it perishes because it is unable to completely free itself from the case exuvia. During moulting the integument splits medially along the dorsal surface between the head and the thorax ; the neanide then drags itself out of its exuvia and remains immobile until the new integument is fully expanded and hardened.

At each moult, the insect undergoes changes in its external appearance which are more pronounced in the later instars. In the third instar, the typical leaf-like expansions of the hind tibiae become apparent and the wing buds are visible, although they are not clearly obvious until the following instar.

The neanides are gregarious and it is often possible to see several stages and sometimes even adults on the same plant.

## GEOGRAPHICAL DISTRIBUTION

*Leptoglossus australis* (F.) has been found in 12 of the 15 districts of the Territory of Papua and New Guinea. There are no data from the Western District, the Southern Highlands, and the Manus districts. It is most likely that this species occurs also in these three districts but very little entomological collection was carried out in these areas.

The following list of localities where *Leptoglossus australis* (F.) was taken is based on the material in the entomological collections of the Department of Agriculture, Stock and Fisheries at Port Moresby, at Highlands Agricultural Experiment Station, Aiyura, and at Agricultural Experiment Station, Bubia.

*Territory of Papua*

Central District : Aroa Estate, Bogura, Bomana, Brown River area, Doa Plantation, 14-mile Farm (near Port Moresby), Javerere Plantation, Kanosia Plantation, Lolorua Plantation, Port Moresby (Lawes Road hill, 3-mile hill and Boroko), 17-mile Farm (near Port Moresby.)

Northern District : Biage (1,200-1,400 ft.), Kogona Plantation, Mamoo Plantation (1,000 ft.), Popondetta.

Gulf District : Ihu.

Milne Bay District : Esa'ala (Normanby Island), Kiriwina (Trobriands).

*Territory of New Guinea*

Sepik District : Bainyik Agricultural Station, Tanbada Settlement (near Wewak), Wewak (gardens of the Corrective Institution).

Madang District : Amele Plantation.

Morobe District : Arou area (south side of the Markham Valley, about 500 feet above sea level), Bubia Agricultural Experiment Station, Bulolo (about 2,400 ft.), Munum Village, Wau (3,000 ft.).

Western Highlands District : Korn Farm (4,700 ft.).

Eastern Highlands District : Goroka, Ovihaka Plantation, Wallis Plantation. (Altitudes 5,000-5,400 ft.).

New Britain District : Lowlands Agricultural Experiment Station, Keravat.

New Ireland District : Fatmilak Village, Lagakot Plantation (Lihir Island), Lakurafanga Plantation, Vuonapili Mission (Lihir Island).

Bougainville District: Kieta, Numa Numa Plantation, Wakunai Village.

In addition to the authors, the material was collected by Mrs. E. Anderson (Port Moresby) and by Messrs. J. H. Ardley (Bubia), J. H. Barrett (Aiyura), L. Byrne (Port Moresby), R. S. Carne (Keravat), W. E. Casey (Popondetta), K. S. Cole (Kundiawa), E. Cleland (Aroa Estate), G. S. Dun (Keravat), I. Edward (Keravat), L. A. Edwards (Port Moresby), W. Eliu (Ihu), W. V. Furniss (Port Moresby), G. Gitti (Port Moresby), E. Gray (Port Moresby), E. Green (Kanosia Estate), J. Healy (Brisbane), H. Kombega (Popondetta), A. H. Mann (Port Moresby), N. Standford (Numa Numa Plantation) and W. A. Van den Berk (Doa Estate).

The above-mentioned distribution data show that *Leptoglossus australis* (F.) is a eurythermous and eurytopus species. It occurs in the savannah and monsoon forest area, where the yearly rainfall is only 30-50 inches and in rain forest areas with up to 180 inches of rainfall. It was found at various altitudes between sea level and 5,400 feet.

Regarding the distribution of this species in areas outside the Territory of Papua and New Guinea, the authors were able to trace the following records: Guam, Marianas, Carolines (Oakley, 1953), Brit. Solomon Islands (Lever, 1948), New Caledonia (Cohic, 1951), New Hebrides (Cohic, 1953), Fiji (Lever, 1946), Western Samoa (Hopkins, 1927).

Dr. M. S. K. Ghauri (Commonwealth Institute of Entomology, London) kindly reported (in litt. 15th January, 1960) that the specimens of *Leptoglossus australis* (F.), kept in the collection of the British Museum, were collected in the following areas: "New Guinea, Solomon Islands, Queensland, New Hebrides, Kanala (North New Caledonia), Society Islands, Apia (Western Samoa), Samoan Islands, Navigator-Islands-Samoan Islands."

## HOST PLANTS

As mentioned in the introduction, *Leptoglossus autralis* (F.) was observed feeding on 26 plant species representing 15 families. The most important host plants are some species of the families Passifloraceae and Cucurbitaceae. On two occasions severe damage to plants of the families Myrtaceae and Rutaceae was also observed.

Very severe damage to passionfruit (*Passiflora edulis*) was recorded from the Asaro Valley (Eastern Highlands of New Guinea) in 1954. (Szent-Ivany, 1958.) Serious injury to rockmelon (*Cucumis melo*) was observed by Mr. F. X. Ryan at Ihu, in the Gulf District of Papua, where the fruits were completely covered by all instars of *Leptoglossus australis* which caused complete decomposition of the fruits. (In litt. 17th June, 1960.) Some damage to grenadilla (*Passiflora quadrangularis*) and to cucumber (*Cucumis sativa*) by this species was found by the senior author in the Northern District of Papua. Severe fruit fall of mandarins (*Citrus reticulata*) occurred in an orchard at Bulolo (Morobe District) as a result of attack by *Leptoglossus australis*. The flying adults swarmed into the orchard, where mandarin and grapefruit trees (*Citrus paradisi*) were planted. They attacked the unripe young mandarins, causing almost complete fruit fall, but left the grapefruit untouched. Similar damage to citrus in Queensland by *Leptoglossus bidentatus* is recorded in "The Queensland Agricultural and Pastoral Handbook". (Brisbane, 1951, p. 101.) Damage to the foliage of kamerere (*Eucalyptus deglupta*) in a young plantation of the Department of Forests at the Brown River was observed by E. C. Gray and the senior author. (Szent-Ivany & Womersley, 1958.) This was a combined attack by three different sucking insects—*Leptoglossus australis* (F.), the shield bug *Austromalaya* sp. (Family Pentatomidae) and the leafhopper *Paratella erudita* Mel. (Family Flatidae.) The symptoms of the damage were rather spectacular. Before the wilting leaves had dropped to the ground, they showed bright yellow, reddish brown and dark brown colours, giving the plantation the appearance of a temperate climate forest in late autum.

Although *Leptoglossus australis* was observed feeding on 19 other cultivated plants in the Territory of Papua and New Guinea, the damage caused to these plants has never reached the level of economic injury. They seem to be only "occasional feeders" on these plants.

Of the plants of no economic importance, the wild passionfruit (*Passiflora foetida*) is a much-favoured host plant of *Leptoglossus australis*. In the Morobe District, however, the apparently introduced cucurbit *Momordica Charantia* (used sometimes as a cover crop in plantations) seems to be the preferred host. According to the ob-

servations of the junior author, feeding occurs on all parts of this plant but the sweet mucilage around the seeds is most preferred, followed by the ripened fruits, green fruits, stems and leaves.

The names of all host plants observed in the Territory of Papua and New Guinea are listed below :—

Family Araceae :

*Colocasia* sp. (taro).

Family Convolvulaceae :

*Ipomoea batatas* (sweet potato ; leaves and vines).

Family Cruciferae :

*Brassica oleracea* (cabbage).

Family Cucurbitaceae ;

*Cucumis melo* (rockmelon).

*Cucumis sativus* (cucumber).

*Cucurbita pepo* (pumpkin).

*Momordica Charantia.*

Family Dioscoreaceae :

*Dioscorea* sp. (yam).

Family Euphorbiaceae :

*Hevea brasiliensis* (rubber ; seedlings).

*Manihot utilissima* (cassava).

Family Gramineae :

*Sorghum vulgare* (millet ; stem and panicles).

*Oryza sativa* (rice ; stalk).

Family Labiatae :

species indet.

Family Leguminosae :

*Cajanus cajan* (pigeon pea).

*Centrosema pubescens.*

*Crotalaria anagyroides.*

*Erythrina indica* (dadap ; planted as shade tree in a cacao plantation).

Family Malvaceae :

*Hibiscus savdariffa* (rosella).

Family Mirtaceae :

*Eucalyptus deglupta* (kamerere).

Family Passifloraceae :

*Passiflora edulis* (passionfruit).

*Passiflora foetida* (wild passionfruit).

*Passiflora quadrangularis* (grenadilla).

Family Rubiaceae :

*Coffea arabica* (leaves of young trees, young shoots).

*Gardenia* sp.

Family Rutaceae :

*Citrus reticulata* (mandarin : fruit).

*Citrus* sp. (Papuan lemon : fruit, leaves).

Family Sterculiaceae :

*Theobroma cacao.* (cacao ; *Leptoglossus australis* was observed on various occasions feeding on young shoots, on the stems of seedlings, on leaves, etc., but it has never been found feeding on cacao pods, as some other coreids do) (Brown, 1958, 1958a.)

In other parts of the South Pacific area, *Leptoglossus australis* was also found feeding on beans (*Phaseolus* sp.) (Dumbleton, 1954), on tomato (*Lycopersicum esculentum*) (Lever, 1948, Dumbleton, 1954) and on egg plant (*Solanum melongena*). (Lever, 1946, Pemberton, 1954, Dumbleton, 1954.) Oakley (1953) found *Leptoglossus australis* to be very abundant on *Passiflora foetida* on various Micronesian Islands (Palau, Truk, Ulithi, Guam, Saipan, Tinian) but it seldom attacked cultivated plants such as cucumber, melon, pumpkin and squash.

## NATURAL ENEMIES.

Very little is known of natural enemies of *Leptoglossus australis* in the Territory of Papua and New Guinea. The senior author observed the reduviids *Graptoclopius pallescens* and *Helonotus* sp. preying upon nymphs in the forest plantation near the Brown River. (Szent-Ivany and Womersley, 1958.)

## CHEMICAL CONTROL

*Leptoglossus australis* (F.) is highly susceptible to D.D.T. in the form of a 0.2 per cent. spray. It is inadvisable, however, to use D.D.T. or other chlorinated hydrocarbon insecticides on cucurbits due to possible phytotoxicity. On these plants two 0.2 per cent. malathion sprays should be applied, the second 12 days after the first to kill any immature forms which may have hatched in the intervening period.

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# NOTES ON DEFICIENCY SYMPTOMS IN FORESTRY NURSERIES

S. C. Baseden *

AN investigation of extensive chlorosis and subsequent bud rot among Klinki (*Araucaria Klinkii*) and hoop pine (*A. cunninghamii*) seedlings at Bulolo revealed that unavailability of iron at the high soil and water pHs was responsible for the condition.

Severe chlorosis and stuntedness throughout teak (*Tectona grandis*) nurseries at Keravat on colluvial soils of low organic matter content, proved to be due to a deficiency of nitrogen.

Symptoms similar to those present at the seedling stage can be found in young trees in the field, indicating that the sensitivity of Klinki and hoop pine to alkaline conditions and of teak to low nitrogen soils are factors to be considered in the selection of nursery sites for these trees.

## KLINKI AND HOOP PINE

Since 1953, the manufacture of quality plywood from Klinki and hoop pine has become a major industry in the Territory of Papua and New Guinea, and in 1958 was second only to copra in value. The natural resources of these timbers are limited and the long-term prosperity of the industry depends on the success of the reforestation programme being carried out by the Administration.

This report is concerned with one problem which confronted the Department of Forests—the debilitation and, to some extent, loss of seedlings at the nursery stage.

### *Symptoms in Klinki*

The terminal leaves become a uniform yellow tending towards whiteness, while the lower leaves remain dark green. As a secondary effect, bud rot of the chlorotic terminals often follows.

### *Symptoms in Hoop*

Hoop seedlings exhibit identical symptoms, but appear to be a little less susceptible to chlorosis than Klinki.

An investigation of the nursery soils revealed a close relationship between the pH and the severity of the chlorosis in Klinki seedlings.

TABLE I.

Soil pH and Chlorosis comparison.

| SOIL pH (0-4 inches) * | SYMPTOMS. |
|---|---|
| 6-7 | Invariably absent. |
| 7.0-7.5 | Slight and rarely present. |
| 7.5-8.0 | Marked and generally present. |
| 8.0-8.4 | Invariably present and very severe. |

(* soil/water ratio 1 : 5 for pH determination with glass electrode).

The high pH values of the soil and the pattern of the chlorosis strongly suggested that a deficiency of one or more of the trace elements, particularly iron, was responsible. Accordingly, spray trials were designed and carried out by officers of the Department of Forests, and soil applications of sulphur to reduce the pH were recommended.

A composite spray, including magnesium and all trace elements except iron, produced no response. A marked response was obtained to spraying with one per cent. iron citrate with a wetting agent, and to the application of sulphur to the soil at the rate of 1.6 tons per acre. Similar responses were obtained with hoop seedlings.

It was concluded that iron had been rendered unavailable at the high soil pHs, and was responsible for the chlorotic condition of the seedlings, the position being further aggravated by the nursery water supply, which had a pH value of 8.4. Spraying with an iron compound appeared to be a less effective control measure than modification of the soil pH. This was considered to be due to the small leaf area presented by the hoop seedlings for absorption and the waxy nature of the leaf surface of the Klinki, which restricted penetration.

A very similar pattern of chlorosis occurs in young Klinki trees, in a nursery where the topsoil had a pH of 7.3 and the subsoil 8.0. It is evident that where there is a choice of soils for nurseries and reforestation those which are alkaline should be avoided.

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## KERAVAT TEAK CHLOROSIS

At Keravat, in the New Britain District, experiments have been in progress for some time on the establishment of teak on a plantation basis. Material for these experiments comes from nurseries located on river flats, which are composed largely of coarse pumice with silt and volcanic ash intermixed, and have a low humus and clay content.

At the request of the Forestry Department, an inspection was made in 1957 of the chlorotic and stunted condition of the teak, which was present throughout these nurseries.

### *Symptoms in Teak*

In the early stages, the chlorosis takes the form of an interveinal yellowing in the older leaves. As the condition becomes more severe, chlorosis extends to the younger leaves, and older ones become completely yellow with necrotic margins.

A one per cent. urea spray also produced clear evidence of a response in three weeks, but appeared to be less effective than the soil treatment.

The soils of the river flats are made up of colluvial debris and are characteristically low in organic matter, generally containing less than 0.2 per cent. total nitrogen in the 0-3 inch layer. By way of contrast, on higher ground where soils have developed under mature forest on volcanic ash, the total nitrogen content at 0-3 inch ranges between 0.8 and 1.0 per cent. In the field, it is evident that teak performs better on the latter soil, whereas trees such as kamerere (*Eucalyptus deglupta*) appear to be well adapted to the former.

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